1. PUBLIC HEALTH STATEMENT

This public health statement tells you about cesium and the effects of exposure.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal cleanup activities. Stable cesium has been found in at least 10 of the 1,585 current or former NPL sites. It was reported that ^{134}Cs has been found in at least 3 of the 1,585 current or former NPL sites and ^{137}Cs has been detected in at least 22 of the 1,585 current or former NPL sites. However, the total number of NPL sites evaluated for this substance is not known. As more sites are evaluated, the sites at which cesium is found may increase. This information is important because exposure to this substance may harm you and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You are exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance, or by skin contact.

If you are exposed to cesium, many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

1.1 WHAT IS CESIUM?

Cesium is a naturally occurring element found in rocks, soil, and dust at low concentrations. Granites contain an average cesium concentration of about 1 part of cesium in a million parts of granite (ppm) and sedimentary rocks contain about 4 ppm. Natural cesium is present in the environment in only one stable form (isotope), ^{133}Cs. Pure cesium metal is silvery white in color and very soft, but pure cesium is not expected to be found in the environment. Pure cesium

metal reacts violently with air and water resulting in an explosion-like reaction. Cesium compounds do not react violently with air or water and are generally very soluble in water. The most important source of commercial cesium is a mineral known as pollucite, which usually contains about 5–32% cesium oxide (Cs_2O). No known taste or odor is associated with cesium compounds. Cesium is not mined or produced in the United States and very little is imported from other countries. There are relatively few commercial uses for cesium metal and its compounds. Sometimes cesium is used to absorb for residual gas impurities in vacuum tubes and as a coating in tungsten filaments or cathodes of the tubes. Cesium iodide and cesium fluoride are used in scintillation counters, which convert energy from ionizing radiation into pulses of visible light. Cesium is also used in highly accurate atomic clocks. For more information on the physical and chemical properties and on the production and use of cesium, see Chapters 4 and 5.

Radioactive forms of cesium are produced by the fission of uranium in fuel elements (fuel rods) during the normal operation of nuclear power plants, or when nuclear weapons are exploded. Radioactive forms of cesium are unstable and eventually change into other more stable elements through the process of radioactive decay. The two most important radioactive isotopes of cesium are ^{134}Cs and ^{137}Cs. Radioactive isotopes are constantly changing into different isotopes by giving off radiation. Each atom of ^{134}Cs changes into either xenon-134 (^{134}Xe) or barium-134 (^{134}Ba) neither of which is radioactive, while each atom of ^{137}Cs decays to barium-137 (^{137}Ba), which is also not radioactive. As ^{134}Cs and ^{137}Cs decay, beta particles and gamma radiation are given off. The half-life is the time it takes for half of that cesium isotope to give off its radiation and change into a different element. The half-life of ^{134}Cs is about 2 years and the half-life of ^{137}Cs is about 30 years.

1.2 HOW DO WE MEASURE RADIOACTIVITY?

Cesium is measured in units of mass (grams) or radioactivity (curies or becquerels). Both the curie (Ci) and the becquerel (Bq) tell us how much a radioactive material decays every second. The Bq is a new international unit known as the SI unit, and the Ci is an older unit, but it is more commonly used. The Ci was the original unit used to describe the intensity of radioactivity.

One Ci is equal to 37 billion radioactive emissions per second; this is approximately the radioactivity of 1 gram of radium. One Bq is equal to 1 radioactive emission per second. Thus,

1 Ci=37,000,000,000 Bq and

1 Bq=0.000000000027 Ci.

The table below gives the conversion between these units and the prefixes used. You can use the table to convert from one unit to the other. To do this, look at the first row of the table. You will see that 1 kilocurie (1 kCi) is equal to 37 terabequerels (37 TBq). To convert a different amount of radioactivity, say 5 pCi to Bq, using the table, you would first find that 1 pCi is equal to 37 mBq. Then you would multiply the 37 mBq by 5 to obtain 185 mBq (5 pCi=185 mBq).

Conversion of Radioactivity Units

Conventional Units			SI Units		
	prefix			prefix	
1 kCi	kilo	$1x10^{3}$ Ci	37 TBq	tera	$37x10^{12}$ Bq
1 Ci	—	$1x10^{0}$ Ci	37 GBq	giga	$37x10^{9}$ Bq
1 mCi	milli	$1x10^{-3}$ Ci	37 MBq	mega	$37x10^{6}$ Bq
1 µCi	micro	$1x10^{-6}$ Ci	37 kBq	kilo	$37x10^{3}$ Bq
1 nCi	nano	$1x10^{-9}$ Ci	37 Bq	—	$37x10^{0}$ Bq
1 pCi	pico	$1x10^{-12}$ Ci	37 mBq	milli	$37x10^{-3}$ Bq
1 fCi	femto	$1x10^{-15}$ Ci	37 µBq	micro	$37x10^{-6}$ Bq
1 aCi	atto	$1x10^{-18}$ Ci	37 nBq	nano	$37x10^{-9}$ Bq

Conversion of Radioactivity Units

SI Units			Conventional Units		
	prefix			prefix	
1 TBq	tera	$1x10^{12}$ Bq	27 Ci	—	$27x10^{0}$ Ci
1 GBq	giga	$1x10^{9}$ Bq	27 mCi	milli	$27x10^{-3}$ Ci
1 MBq	mega	$1x10^{6}$ Bq	27 µCi	micro	$27x10^{-6}$ Ci
1 kBq	kilo	$1x10^{3}$ Bq	27 nCi	nano	$27x10^{-9}$ Ci
1 Bq	—	$1x10^{0}$ Bq	27 pCi	pico	$27x10^{-12}$ Ci
1 mBq	milli	$1x10^{-3}$ Bq	27 fCi	femto	$27x10^{-15}$ Ci

1.3 WHAT HAPPENS TO CESIUM WHEN IT ENTERS THE ENVIRONMENT?

Naturally occurring cesium occurs in the environment mostly from the erosion and weathering of rocks and minerals. The mining and milling of certain ores can also release cesium to the air, water, and soil. Radioactive cesium is released to the environment during the normal operation of nuclear power plants, explosion of nuclear weapons, and accidents involving nuclear power plants or nuclear powered satellites or submarines.

Non-radioactive cesium can be neither created nor destroyed under typical environmental conditions, but can react with other compounds found in the environment and change into different cesium compounds. Radioactive decay is the only way for decreasing the concentration of ^{134}Cs and ^{137}Cs. Both stable and radioactive cesium are the same element and behave in a similar manner chemically and in the body. Cesium can travel long distances in the air before being brought back to the earth by rainfall and gravitational settling. In water and moist soils, most cesium compounds are very soluble. Cesium binds strongly to most soils and does not travel far below the surface of the soil. Consequently, it is not readily available for uptake by vegetation through roots. However, radiocesium can enter plants that fall onto the surface of leaves.

1.4 HOW MIGHT I BE EXPOSED TO CESIUM?

You can be exposed to stable or radioactive cesium by breathing air, drinking water, or eating food containing cesium. The level of cesium in air and water is generally low. The concentration of natural cesium in air is generally less than 1 nanogram (1 nanogram equals 1/1,000,000,000 of a gram) per cubic meter of air (ng/m^3). Cesium concentrations in drinking water is ordinarily about 1 microgram (1 microgram equals 1/1,000,000 of a gram) per liter of water (µg/L). On average, a person swallows about 10 µg of stable cesium per day in food and water, and breathes about 0.025 µg per day. Plants and animals have been shown to contain cesium at concentrations of about 1–300 ng/g.

Radioactive cesium has been detected at some level in surface water and in many types of food. This includes breast milk and pasteurized milk. The amount of radioactive cesium in food and milk is highly dependent upon several factors. The most important factor is whether or not there has been recent fallout from a nuclear explosion such as a weapons test or an accident that has occurred at a nuclear power plant. However, atmospheric testing of nuclear weapons was halted many years ago, and there have only been two major accidents at nuclear plants where radiocesium was released in significant amounts. The two accidents occurred in Windscale, England in 1957 and Chernobyl, Russia in 1986. You should understand that cesium only contributed a small fraction of the total radioactivity released following these events. Furthermore, the consequences of external exposure to gamma radiation and beta particles are not unique to ^{137}Cs and ^{134}Cs, but are very similar for all gamma and beta emitting radionuclides. People who work in industries that process or use natural cesium or cesium compounds can be exposed to higher-than-normal levels of cesium. An estimated 16,461 workers (4,276 of these are female) are potentially exposed to natural cesium and cesium compounds in the United States. If you work in the nuclear power industry, you may also be exposed to high levels of radioactive cesium, but there are many precautionary measures taken at these facilities to minimize this exposure.

1.5 HOW CAN CESIUM ENTER AND LEAVE MY BODY?

Stable and radioactive cesium can enter your body from the food you eat or the water you drink, from the air you breathe, or from contact with your skin. When you eat, drink, breathe, or touch things containing cesium compounds that can easily be dissolved in water, cesium enters your blood and is carried to all parts of your body. Cesium is like potassium; it enters cells and helps to maintain a balance of electrical charges between the inside and the outside of cells so that cells can perform tasks that depend on those electrical charges. Cells like muscle cells and nerve cells require changing electrical charges in order to function properly and allow you to think and move.

Once cesium enters your body, your kidneys begin to remove it from the blood; some cesium is quickly released from your body in the urine. A small portion is also released in the feces.

Some of the cesium that your body absorbs can remain in your body for weeks or months, but is slowly eliminated from your body through the urine and feces.

1.6 HOW CAN CESIUM AFFECT MY HEALTH?

To protect the public from the harmful effects of toxic chemicals and to find ways to treat people who have been harmed, scientists use many tests.

One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body. In the case of a radioactive chemical, it is also important to gather information concerning the radiation dose and dose rate to the body. For some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. Scientists have the responsibility to treat research animals with care and compassion. Laws today protect the welfare of research animals, and scientists must comply with strict animal care guidelines.

You are not likely to experience any health effects that could be related to stable cesium itself. Animals given very large doses of cesium compounds have shown changes in behavior, such as increased activity or decreased activity, but it is highly unlikely that you would breathe, eat, or drink amounts of stable cesium large enough to cause similar effects. If you were to breathe, eat, drink, touch, or come close to large amounts of radioactive cesium, cells in your body could become damaged from the radiation that might penetrate your entire body, much like x-rays, even if you did not touch the radioactive cesium. You might also experience acute radiation syndrome, which includes such effects as nausea, vomiting, diarrhea, bleeding, coma, and even death. A number of people in Brazil, who played with radioactive cesium that was stolen from a medical machine used for radiation therapy, became sick from exposure to the radiation; a few of them died. But people exposed to radioactive cesium that has been widely dispersed in air, water, soil, or food following nuclear bombings or accidents have not been exposed to amounts large enough to cause the same effects.

1.7 HOW CAN CESIUM AFFECT CHILDREN?

This section discusses potential health effects from exposures during the period from conception to maturity at 18 years of age in humans.

Children can be affected by cesium in the same ways as adults. Cesium is not likely to affect the health of children, but large amounts of gamma radiation, from sources such as radioactive cesium, could damage cells and might also cause cancer. Short exposure to extremely large amounts of radiation might cause nausea, vomiting, diarrhea, bleeding, coma, and even death. In addition, if babies were to be exposed to enough radiation while in their mother's womb during the time when their nervous system is rapidly developing, they could experience changes in their brains that could result in changes in behavior or decreased mental abilities. However, it is unlikely that children or babies would be exposed to enough gamma radiation from a radioactive cesium source to do such damage to their bodies.

1.8 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO CESIUM?

If your doctor finds that you have been exposed to significant amounts of cesium, ask whether your children might also be exposed. Your doctor might need to ask your state health department to investigate.

Stable Cesium. Since cesium is naturally found in the environment, we cannot avoid being exposed to it. However, the relatively low concentrations present do not warrant any immediate steps to reduce exposure.

Radioactive Cesium. You are unlikely to be exposed to high levels of radioactive cesium unless there is a fuel meltdown and accidental release at a nuclear power plant or a nuclear weapon has been detonated. In such cases, follow the advice of public health officials who will publish guidelines for reducing exposure to radioactive material when necessary.

1.9 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO CESIUM?

Everyone has small amounts of cesium in their body. Laboratories use special techniques to measure the amount of cesium in body fluids such as blood and urine, as well as in feces or other human samples. This can give an indication of whether a person has been exposed to levels of cesium that are higher than those normally found in food, water, or air. Special radiation detectors can be used to detect if a person has absorbed radioactive cesium. It is difficult to determine if a person has been exposed only to external radiation from radioactive cesium. Health professionals examining people who have health problems similar to those resulting from radiation exposure would need to rely on additional information in order to establish if such people had been near a source of radioactivity.

1.10 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), the Food and Drug Administration (FDA), and the Nuclear Regulatory Commission (NRC).

Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH), and the FDA.

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals; then they are adjusted to help protect people. Sometimes these not-to-exceed levels differ among federal organizations because of

different exposure times (an 8-hour workday or a 24-hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for cesium include the following:

There are few guidelines for compounds of stable cesium. Based on eye irritation, the NIOSH has established a recommended exposure limit (REL) for cesium hydroxide of 2 mg/m^3 as a time-weighted average (TWA) for up to a 10-hour workday and a 40-hour workweek. The American Conference of Governmental Industrial Hygienists (ACGIH) has assigned cesium hydroxide a threshold limit value (TLV) of 2 mg/m^3 as a TWA for a normal 8-hour workday and a 40-hour workweek, based on respiratory and eye irritation.

Radioactive cesium. The NRC established occupational inhalation exposure derived air concentrations (DACs) of 0.00000004 μCi/mL ($4x10^{-8}$ μCi/mL) for ^{134}Cs and 0.00000006 μCi/mL ($6x10^{-8}$ μCi/mL) for ^{137}Cs; annual limit intakes (ALIs) for on-the-job exposure are 100 μCi ($1x10^{2}$ μCi) for ^{134}Cs and 200 μCi ($2x10^{2}$ μCi) for ^{137}Cs.

The NRC also established limits for effluent concentrations of 0.0000009 μCi/mL ($9x10^{-7}$ μCi/mL) for ^{134}Cs and 0.000001 μCi/mL ($1x10^{-6}$ μCi/mL) for ^{137}Cs in water, as well as 0.0000000002 μCi/mL ($2x10^{-10}$ μCi/mL) for both ^{134}Cs and ^{137}Cs in air.

More information on regulations and guidelines is available in Chapter 8.

1.11 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department, your regional Nuclear Regulatory Commission office, or

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, Mailstop E-29
Atlanta, GA 30333

* Information line and technical assistance

Phone: 1-888-42-ATSDR (1-888-422-8737)
Fax: (404) 498-0057

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses resulting from exposure to hazardous substances.

* To order toxicological profiles, contact

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Phone: 1-800-553-6847 or (703) 605-6000